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THE EFFECT OF NOISE BARRIERS ON THE MARKET VALUE OF ADJACENT RESIDENTIAL PROPERTIES

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Abstract

This paper addresses the problem of how highway noise affects house prices, and how highway noise barriers alter that effect. The project began with a set of house price data available in the Property Office of the Ontario Ministry of Transportation and Communications. These data were augmented with housing characteristics and sales data obtained from the Toronto Real Estate Board. All of the data were from three residential areas of Toronto situated behind highway noise barriers. In a multiple linear regression, in which a variety of other housing characteristics are controlled for, the coefficient on noise level (in 1981 dollars) varies from -312 $/dB at one site, to -356 $dB at a second site, to -2971 $/dB at a third site, all of which coefficients are statistically significant at the .05 level. The pooled sample estimate is -778 $/dB. The first two values are generally consistent with results of earlier studies, although perhaps a bit lower. Non-linear regressions on noise level, and functions which ignored noise until it was in the mid-60s, were also investigated. Those results supported neither a quadratic function, nor any clear threshold effect.

Close inspection of the data at the site with a -2971 $/dB value suggests that these data may not be representative of the relevant population, in that expensive houses in high noise environments are not properly represented in the sample. As a result, the extremely large estimated noise penalty is probably a statistical anomaly. Since the pooled sample noise penalty of -778 $/dB reflects in part the data from that site; it too may be non-representative of the population noise penalty.

It is clear from these data that house sales in areas protected by noise barriers reflect the same kind of valuation of noise as do houses in unprotected noisy areas.

INTRODUCTION

Highway noise has several detrimental effects on people living adjacent to the highways. When the noise level is high enough, these effects are severe enough to be reflected in housing prices. Several previous studies have been conducted to estimate this effect, but none of these have been conducted in areas where highway noise barriers are present.

The main question addressed in this study is whether and to what extent barriers overcome the impact highway noise has on house prices. In particular, is the $/dB effect at locations with noise barriers commensurate with the $/dB effect at sites without barriers? In order to obtain a good answer to this question, the research also considers whether it is correct to speak of a $/dB effect (which implies a linearity of effect over the range of the data), or whether the effect is a non-linear function of the decibel level.

The most relevant of the previous studies for purposes of comparison is the one reported in Taylor, Breston, and Hall (1982), based on work done for a Master's thesis by Breston at McMaster University. That study utilized data on 2277 individual housing sales at 51 sites in southern Ontario, and involved collection of highway noise data at those sites specifically for the analysis. The results showed that noise was valued at approximately 250-300 $/dB (in 1977 dollars), comparing similar housing at different distances (and therefore noise levels) from the roadway. For the average house price of $60,000, this represents a depreciation rate of 0.5% per decibel. Noise level differences between the first two rows of housing parallel to a highway ranged from 7 to 16 dB in that study, implying that the effect of the noise varied between 3.5% and 8% of the price of similar but quieter housing. Because that study was conducted in southern Ontario, and used detailed noise level data, its results should provide the most appropriate comparison for results of the current study.

Nelson (1978b) reports on a study using 1970 census data for 456 tracts for the Washington, D.C. metropolitan area. His results "imply that a 1 dBA increase in L_{dn} will decrease a given property value by about 0.8 percent, all other things being equal" (p. 95). Unfortunately this study did not collect noise data, and was not based on individual sales data. Instead, census tract data for average sales prices and average housing characteristics were used, and noise levels were estimated based on population densities.

Nelson also provides a summary of three earlier studies of road traffic noise house price effects, for which the results are all remarkably similar. Gamble _et al._ (1974) find decreases in property values of between 0.20% and 0.42% per dB, except for one site where the decrease as estimated by the regression equation was 2.22% per dB. Anderson and Wise (1977) obtain a pooled sample result of 0.25% per dB, which compares very closely with a pooled sample result of 0.26% per dB for Gamble _et al._ Both Gamble _et al._ and Anderson and Wise used the same data, individual real-estate records for four Eastern U.S. communities. The Gamble _et al._ data were for the period 1969 to 1971, with an average house price of $31,100 across the sample. The Anderson and Wise study covered the period 1965 to 1971. No average value is available. Within specific sites, however, the Anderson and Wise results varied considerably, from a non-significant effect at two sites to as high as 1.0% per dB. Vaughn and Huckins (1975) found results ranging from 0.4 to 0.6% per dB, depending on the noise measure and regression form, with a best estimate of about 0.6% per dB. They used a Chicago-based sample for the period 1971-72, with an average house price of $22,500.

This paper is based on data from Toronto, Ontario, collected at two sites with noise barriers and at a third with data from before and after barrier construction. The study began with data previously acquired by the Property Office of the Ontario Ministry of Transportation and Communications (MTC). The existence of those data determined the sites to be used for the present study, which was limited to three locations in the Toronto metropolitan area. The first analysis reported here was based solely on the MTC data. A second analysis drew upon additional data for the same three sites, collected from the Toronto Real Estate Board. The next two sections describe those analyses, starting with a brief description of the available data for each. The final section of the paper compares these results with those from the earlier studies, and suggests some possibilities for additional research.

ANALYSIS OF MTC PROPERTY OFFICE DATA

Recent data available in the MTC Property Office files come from 3 sites in Toronto:

1. Etobicoke, along Hwy 427, before barrier construction (and with a few observations since a concrete barrier was erected);
2. Between Leslie Street and Bayview Avenue, along Hwy 401, after barrier construction;
3. Between the Don Valley Parkway and Victoria Park Avenue, along Hwy 401, after barrier construction.

For these sites, the files contain information on the recent sale price and the date of the sale, the original sale price at the time that the house was first built and the date of that sale, the lot size, and the amount of cash paid as part of the sale.

The first step to prepare these data for a multiple regression analysis of house price on its determinants was to remove the effects of inflation from the house prices over the period covered by the data. Several price indices were considered for this purpose: the owned accomodation component of the Consumer Price Index; the residential construction cost index; and an index of average prices for Toronto real estate sales. The real estate index was chosen for four main reasons. First, it clearly incorporates seasonal effects and the effects of brief periods of speculative activity in the housing market, which neither of the other indexes does. Second, the owned accomodation index includes many items which are extraneous for consideration of sale price (for example, utility and heating charges, and repair costs), and also includes costs associated with condominium ownership in the index. Third, the construction cost index cannot include the various factors which affect resale prices of housing, such as market demand, since it is based solely on costs of new home construction. Fourth, the real estate index is available for each of the three Toronto sites, making it the index most representative of the price experience of the homes in the study. These factors combine to make the real estate index the best choice for measuring house price behaviour. The Toronto Real Estate Board made available to us information on the average selling price, for houses only, in each of three districts within Metropolitan Toronto, for each month, January 1977 through November 1985. These prices were used to construct a housing price index, using 1981 as the base year. The sale price for each of the individual sales in the file was then converted to 1981 dollars by division by the index value for the month, year, and location of the actual sale.

Several other variables were also added to the data file. Noise data for each site, used in these and later calculations, were obtained from Soren Pedersen of the Highway Design Office of MTC, who generated the values appropriate to each site using the noise prediction model Stamina 2.0. In all, 107 observations were available for this analysis.

Two regressions were run to identify the $/dB effect. The first used the original sale price as a proxy for the housing characteristics; the second excluded that variable. Results for the two runs are shown in Table 1. The first result to note is that the coefficient on sound is consistent between the two runs: noise is valued at about -466 to -486 $/dB. This coefficent is significant in both cases at the 5% level, but the sample is small. With a larger sample, one might expect this to be significant at more stringent acceptance levels. This value is reasonably close to that found by Taylor, Breston and Hall (1982), of -312 $/dB at expressway sites. The difference between that value and the new one may be due either to the variation still present in the current small sample (standard errors of the regression coefficients are about 270), or to general inflation. Taylor's numbers are in 1977 constant dollars; ours are in 1981 dollars. Applying our price index value from June 1977 to Taylor's results would bring them to -505 $/dB in 1981 dollars, which is remarkably close to the current results.

However, inspection of the coefficients on the other variables suggests that this particular regression is not the strongest possible. The coefficients on Toronto West and on 'detached house' change substantially when the 'original price' is excluded from the equation, suggesting that original price is correlated with these other variables. The simple correlation matrix confirms this. Although the original price acts to some extent as a proxy for housing characteristics, it is at best an imperfect measure for this purpose, since variation in this variable is due to several factors including inflation. Since the housing price index does not go back as far as these original sales, many of which took place in the early 1960s, it is not possible to standardize the original price variable to the 1981 base. Although the effects of inflation are removed from the left-hand side variable in the regressions, these effects are present in the original price variable on the right-hand side. Thus, these results with original price, though quite suggestive, argue strongly for expansion of the data set to include a complete set of housing characteristics.

The secondary question for consideration here is whether the noise effect is linear or nonlinear in dB. There was some indication in the Taylor <u>et al.</u> paper of a threshold noise level below which a noise discount was not found. It seems plausible to expect people to put a larger (negative) dollar value on noise at high noise levels than at low ones, and it is reasonable to suppose also that levels below 55 dB are not likely to engender any negative reactions, or negative pricing. Our analysis above implicitly assumes that the same dollar penalty is placed on a 5 dB noise increment at 70 dB as at 50 dB. Four additional regression runs were carried out to consider other possibilities.

The first two of these were based on a suggestion by Eldred (1983) that the integral over time of the total sound pressure experienced, measured in Pascal-squared seconds, may better reflect individual reaction to noise than a measure based on a logarithmic scale. Eldred's measure contains the assumption that changes in the squared pressure, rather than changes in decibels, are valued equally. For example, moving from 50 to 55 dB would be reflected in a move from roughly 3 to roughly 10 Pascal-squared seconds, or an increase of 7. An increase from 70 to 75 dB would be reflected in this measure in an increase of 680 (from 320 to 1,000). Clearly the implication is that a given dB increment at higher decibel values will be evaluated much more severely on this scale than on the logarithmic decibel scale, if the coefficient on this variable is significant.

The results appearing in Table 2 for this analysis are not encouraging. Without the original price variable in the equation, Eldred's measure is not significant at any conventional level. Even when original price is included, the t-statistic of the coefficient on sound (-1.34) is still not very close to conventional acceptance levels. On the basis of these data, it appears that house prices are more closely related to decibel measures of sound than to measures based on the total sound pressure experienced.

A second procedure to identify non-linearity involved use of a set of dummy variables to characterize the sound levels, in place of the actual decibel value. Intervals of 3 dB were used, starting at 55 dB and going up to 73 dB. The results (Table 3) suggest that there are some anomalies in this small data set that may be producing misleading results. In particular, the coefficients on the noise variable set in this sample do not show a sensible progression, in the sense that people in this sample are willing to pay more, other things being equal, for a home in the noisiest category than for one a bit quieter. This finding is questionable since only 5 of the 107 sales in the sample are in this noisiest group. The procedure itself however has some promise for uncovering non-linearities in the house price effect of highway noise, as evidenced by the shift from positive to negative valuations at 60 dB. The current sample is not, however, appropriate to uncover this effect completely.

ANALYSIS OF DATA FROM TORONTO REAL ESTATE BOARD

The Toronto Real Estate Board keeps as part of the historical records of sales a copy of the original Multiple Listing Service (MLS) card on the sale. Thus there is a brief verbal description of key features of the house, as well as a summary of the most relevant characteristics. A university student was hired to collect and code information from that source to be entered into the computer for analysis. Some of the sales in the MTC Property Office file could not be retained in this new data set because they were not carried on the multiple listing files, and therefore the detailed housing characteristics were not available. On the other hand, because the MLS records spanned a number of years not covered in the MTC studies, there were many more sales for the three sites in the multiple listing files than were contained in the Property Office reports; thus there is a much larger data base for this analysis. The complete sample based on the Toronto Real Estate Board data acquisition contains 394 observations, of which 136 are from the Highway 427 site, 103 are from the Highway 401 and Leslie St. site, and 155 are from the Highway 401 and Victoria Park site.

The complete list of variables used for the regressions is shown in Table 4. As is clear from this list, the Toronto Real Estate Board sample permits regression estimation of noise effects holding constant an extensive set of characteristics likely to influence house prices.

As with the MTC Property Office data set, three measures of noise are used: the 24 hr. L_{eq}; Eldred's proposal; and a set of dummy variables. Each one is used in a separate regression equation. As an additional test of whether non-linear functions of noise might be appropriate, equations are estimated using a noise variable computed as the (dB) difference between the measured level and a threshold level.

The discussion, then, covers four ways of treating the noise variables, and involves estimation across four data sets: the Victoria Park, Etobicoke, and Leslie Street sites, plus the pooled set consisting of all of these. Each of the three sites will be discussed separately first, and then the pooled results will be considered.

(i) The Victoria Park Site

Consider first the Victoria Park or Toronto East site, which has the largest number of observations (155). The complete equation based on 24-hour L_{eq} is shown in Table 5. The implied base case for these estimates is a 1-storey detached house with an unfinished basement, no air conditioning, no pool, and a private driveway but no garage. For such a house, the equation using the dB measure yields an estimated selling price (in 1981 dollars) as follows (assuming that each of the other relevant variables had a value close to its mean for the full sample as shown in Table 4, namely a 60 dB noise level, a 5300 sq.ft. lot, 7 rooms, 1.5 bathrooms, 3 bedrooms, 1 appliance included, and an interest rate of 14.1%):

$$\begin{aligned} \text{Price} &= 93{,}828 - 312*60 - .06639*5300 + 1357*7 + 1984*1.5 \\ &\quad + 1393*3 - 68*1 + 257*14.1 \\ &= \$94{,}966 \end{aligned}$$

This example is a reasonable indication of the nature of the equation. One drawback, however, is that some of the coefficients are not statistically significant in that equation (see Table 5). For example, the coefficient on lot size, −0.06639, has a negative sign, which is contrary to expectations, although it is not significantly different from zero. More importantly, in some equations, the noise variable itself does not have a significant coefficient. Consequently, we have chosen to report results based on the equations with all variables entered, as indicated by the result in Table 5. That table, however, is the only one which will display all the coefficients. Subsequent discussion will be focussed solely on coefficients for the noise variables, from similar equations. These coefficients for all 4 data sets are summarized in Table 6, for three of the noise variables, and in Table 7, which describes results for the threshold functions.

The results in Table 6 for the Victoria Park site, for all three noise variables, are relatively easy to interpret. The 24-hour L_{eq} is significant at the 5% confidence level, and its coefficient indicates that each additional dB reduces the price of a house by, on average, $312.

It is important to be aware that a single coefficient, particularly the one on dB, cannot be interpreted in isolation. In particular, it is not correct to say from this result that locating a house in a 60 dB neighbourhood reduces the selling price by $18,700. The correct interpretation, and the important result of this analysis is that within the range of data available at this site, (roughly 55 to 70 dB, 24-hour L_{eq}), each added dB decreases house prices by roughly $312. Given that the average house price in the area is $87,187 (in constant 1981 dollars), this translates to a change of 0.35% of the house price per dB. The large product of number of dB times this coefficient also explains the large constant term in the equation.

The second variable used to represent noise is Eldred's measure. This variable is also significant at the 5% level. The change in magnitude of the estimated coeffficient is simply a function of the different scale of the underlying noise variable, as discussed earlier. When translated back to its dB equivalent, this measure gives a non-linear shape for the relationship. This figure led us to attempt quadratic functions of the 24-hour L_{eq}, which were not supported by the data, as well as the threshold functions reported in Table 7. Not only does the pressure-squared measure produce a non-linear function (which it should by the very nature of the variable), but also the set of dummy variables representing noise intervals constitutes an approximation to a non-linear function.

The interval results also suggest some peculiarities of these data at the Victoria Park Site, which stand out very clearly in Figure 1, as well as in Table 6. In particular, at one level, an increase in the noise level is associated with an increase in the selling price of the house: moving from levels in the 55-57 dB range to levels in the 58-60 range adds $1816 to the selling price. However, none of the coefficients for the intervals is statistically significant.

The fourth treatment of the noise variable was by way of a series of regression equations, using a threshold function for noise. The noise variable was defined to be

$$x=0, \quad \text{for } dB<T;$$
$$x=dB-T, \text{ for } dB>T, \quad \text{where } T \text{ is the threshhold.}$$

Values of the threshold, T, from 55 to 65 dB were used, in steps of 1 dB. These results (Table 7) can be interpreted in two ways. The first is to note that there is very little difference in the adjusted R-squared for any of the equations. Hence an argument could be made that a threshhold function is not necessary, and offers little improvement over a linear function. The second interpretation focusses on the changes which do occur (in the third and fourth decimal place of the adjusted R-squared, and in the t-statistic). This view says that the best threshold for the Victoria Park site is 65 dB, and that above that level additional noise is valued at -1804 \$/dB. Selection from among regression equations on the basis of differences in R-squared, however, normally requires greater differences than this, and so the first view is probably correct. There is no evidence from these data that non-linear functions are needed.

(ii) The Etobicoke Site

The results for the Etobicoke site appearing in Table 6 are largely similar to those just discussed for three of the treatments of the noise variable. The coefficient on 24-hour L_{eq} is -356 \$/dB, about \$40 lower than for the Victoria Park site, but quite comparable. The coefficient on Eldred's measure is significant, although smaller than before. The threshold functions again show a change only in the third decimal place of the adjusted R-squared. This time if one were to select the highest R-squared, a threshold of 56 dB would appear to be best. Hence the conjunction of the results for the two sites supports the notion that a threshold function is not warranted.

For the set of dummy variables representing noise intervals, however, there is a difference in these results, in that three of the coefficients are significant. The problem of increasing house prices in noisier areas is still present, however, this time for two steps: that from 58-60 dB to 61-63 dB, and again in the move from 64-66 dB to 67-69 dB. The anomalous coefficients are not significant, however, and so this may be a problem due to a relatively small sample with a non-representative distribution of house prices across the range of noise levels.

(iii) The Leslie Street Site

The results for the Leslie Street site are quite different from those for the previous two sites. For example, the coefficents on 24-hour L_{eq} and on Pascal-squared seconds are roughly an order of magnitude larger than the earlier ones. Likewise the results for the dummy variables and for the threshold functions show much larger coefficients, although otherwise they support the same conclusions as did results for the two previous sites. The question which needs to be addressed is why the coefficients are so much larger at the Leslie Street site.

The first approach attempted was to look for something different about the Leslie Street site. Three possibilities occured to us, arising from the fact that noise is highly correlated with distance from the roadway, and that therefore the coefficient on the noise variable may be biased by the omission of some other correlate of housing price in this area which is also related to distance from the road.

The first possibility is that the important difference is in the type of barrier built at the site. The barrier at the Leslie Street site is a green metal barrier, whereas the other two sites have concrete barriers. If such a barrier is deemed to be unpleasant, then there may well be a property value effect based on living with it in the backyard, as opposed simply to being able to see it, as opposed to not being able to see it. This explanation seems unlikely however.

A second possibility draws on an unusual aspect of the topography at the site. For about half of the length of the site, measured along the expressway, the roadway is elevated relative to the housing. Consequently, the barrier is exceedingly high in some of the backyards, and is very dominant visually. It may well be this 'Great Wall' effect rather than the green metal barrier material which is leading to the difference, but in the same way just explained for the first possibility.

The third possibility is also based on this unusual topography. The prices for the houses closest to the roadway may reflect some kind of fear of the traffic on the elevated roadway, on the part of buyers or prospective buyers, and of the prospect of damage or injury from vehicles leaving the road. The prices would then reflect a risk discount in addition to a noise discount.

To test these last two possible explanations, we revisited the site, and recorded the exact addresses of the houses which experience this 'Great Wall' effect, with the intention of adding a dummy variable to the analysis to represent it. To our considerable surprise, none of the houses with the Great Wall in their backyard were represented in the data file. Therefore, the second and third possibilities can be rejected as irrelevant, and only the first one remains. The only site-related difference we can identify is the difference in the type of barrier.

There is, however, a second answer to the question of how this difference between areas may arise. There is the possibility that the result is simply a statistical anomoly. There is some tentative support for this view. It can be seen in Table 8 that the sample for the Leslie Street site contains very few observations at high noise levels: only 2 in the 70-72 dB range; 11 in the 67-69 dB range, and only 2 in the 64-66 dB range. Sixty-six percent of the observations fall in the 58-60 dB range. These features of the sample raise serious questions about the representativeness of the sample to the population of house prices; a few unusual house prices at high noise levels could easily bias the coefficient on the noise variable.

To further investigate this explanation, the noisiest houses were deleted from the Central Toronto sample, and the analyses were re-run. The results are surprising. When all houses experiencing levels of 67 dB or above were deleted, the regression coefficient on 24-hour L_{eq} dropped sharply (and became non-significant). This suggests some unusual behavior in the joint distribution of noise levels and house prices. The joint distribution of house prices and noise levels for the Leslie Street sample is arrayed in Table 8 and Figure 2. Examination of these pages reveals that, at this site, the more expensive houses are located in quieter environments. For the thirteen data points at noise levels of 67 dB and above, the largest house price (in 1981 constant dollars) is $152,500. Forty-two homes in this sample have higher constant dollar values (ranging up to $272,000) and all of these are at noise levels below 64 dB. To the extent that higher valued houses exist at the higher noise levels, this particular sample may be non-representative of the population joint distribution of house prices and noise levels, and thus noise coefficient estimates based on this sample may be seriously biased.

Given the scale of Figure 2, a population $350/dB noise penalty would be consistent with a population regression function with only a slight negative tilt from the horizontal, to reflect a drop of $4550 over the 13 dB range from 59 to 72 dB in the Leslie Street sample. It is clear from the scatter, however, that an estimated regression line through these data points will have a much steeper slope than this, since, except for outliers at 64 dB, all of the remaining observations at noise levels of 61 dB and above occur at house prices below $153,000, with the majority at prices of less than $120,000. These features lead to the much higher noise penalty (almost $3000/dB) than was found at the Etobicoke and Victoria Park sites.

It is easy to see in Figure 2 that discarding the high noise observations (at or above 67 db) only leads to a steeper negative relationship between house prices and noise levels, as was observed in the calculations. Accordingly, we believe the results for the Leslie Street site must be viewed with skepticism.

(iv) The Pooled Sample

These remarks about the joint distribution of house prices and noise levels for the Leslie Street site also call into question the representativeness of the results estimated for the pooled sample, for example, the coefficient of -775 $/dB on 24-hour L_{eq} (Table 6). It is clear that the Leslie Street sample is the source of the difficulty, since it contains all but one of the high valued homes, all but one of which have low noise levels. Since the Leslie Street sample forms part of the pooled sample, any bias in the noise effect at that site due to non-representativeness of the sample will be built into the pooled sample noise coefficient; if the Leslie Street sample is non-representative, then the figure of -$775/dB simply cannot be generalized to the population as a whole. The same reasoning applies to the other pooled sample coefficients for noise variables in Table 6 and Table 7. Basically, because of the nature of the sample at the Leslie Street site, any results which incorporate those data are probably suspect. With a different sample design, this problem might be eliminated. However, given the fact that the sample was not (and could not have been) designed to maximize the variation in the noise levels, or to have representative numbers of observations at each of the several noise levels, problems of this kind, which can strongly affect the results, are unavoidable. In the pooled sample only 30% of the observations occur in the noisiest 4 of the 7 noise level categories. This is of course to be expected, given the way sound propagates (with equal reductions per doubling of distance, rather than for equal increases of distance away from the source). However, it does make for difficulties in estimating regression coefficients, particularly when housing prices are distributed irregularly as well.

CONCLUSIONS

Two main questions were identified for this paper. Is the $/dB value found in other highway noise property value studies also found at sites with noise barriers? And, is it correct to consider property value effects as a linear function of noise? Unfortunately, this study has not been able to provide unequivocal answers to those questions. The general indication is that the results for housing sales behind barriers are consistent with those of other studies, but there are some differences. Linear functions of noise level perform as well as any other function, but one of the non-linear approaches also performed well.

The main question was whether the $/dB effect at locations with noise barriers is consistent with the effect at sites without barriers. The bases for this comparison were described briefly in the introduction to the report: studies done in the U.S. summarized by Nelson, which reported results in terms of % change in house price for a 1 dB change in noise level; and the study by Taylor <u>et al</u>. conducted in the Toronto area which reported results in a $/dB format. (For the comparison, only the dB noise measure from our study is appropriate; the other non-linear measures were not used in the previous studies.)

The various studies reported by Nelson showed house price effects of noise which ranged from 0.20 to 2.22%/dB, with the great bulk of them being between 0.2 and 1.0%/dB. Pooled sample estimates varied from 0.25%/dB for two studies to 0.8%/dB. For the Property Office data set, our results showed a change, on average of 0.52%/dB. For the Real Estate Board data, the changes were 0.335%/dB in Victoria Park, 2.10 at Leslie Street, 0.39 in Etobicoke, and 0.76 for the pooled sample. These are broadly consistent, even to having one outlier at a value above 2.0%/dB.

Results based on the MTC Property Office data set showed a $/dB value of -466 or -486. This compared very favourably with the Taylor et al. result of -505 $/dB (in 1981 dollars). The results from the more detailed Toronto Real Estate Board data set are not so close to the Taylor results: $/dB values range from -312 in the Victoria Park sample to -2971 at the Leslie Street site, with a pooled sample estimate of -775 (in 1981 dollars). This is 50% higher than in the Taylor study, yet without the Leslie Street data, it appears as if our results would be only about 60% of the Taylor (and Property Office data) results.

This leads to some interesting speculation. With coarse data (the MTC Property Office set, lacking housing characteristics), the $/dB results for noise barriers are broadly consistent with other studies. With more complete data, the new results are generally lower (ignoring the unusual data for the Leslie St. site). If we accept the lower estimate for the noise barrier sites, then this may be partial evidence in favor of a non-linear function between noise levels and house prices. The Taylor et al. result came from locations where the highest noise levels experienced were all above 70 dB. In the two sites whose results we are prepared to accept in this study, only 4 of the 291 observations were at levels above

70 dB. Alternatively, these results may be viewed as partial evidence for the proposition that the noise penalty is lower at barrier sites than at sites without barriers, that is, barriers do matter. However, that must remain speculation; the data are certainly inadequate to provide a clear test of that suggestion.

The overall conclusion is that the results from our analyses are generally consistent with the earlier studies of the house price effects of road traffic noise. This means that noise barriers appear to be fully effective in improving the aural environment, at least as people's perceptions of that characteristic are reflected in housing prices.

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G/FLH6/A/FLH2. /efd

Table 1
Results of Analysis to Find $/dB Value:
MTC Data Set

	Including Original Price			Not Including Original Price		
	Regression Coefficient	Std. Error	t value	Regression Coefficient	Std. Error	t value
Variable						
Original Price	1.90	0.769	2.48	–	–	–
Sound Level	-486.2	267.0	-1.82	-466.0	273.0	-1.70
Lot Area	1.50	1.45	1.03	2.73	1.40	1.95
Toronto Centre	5917.0	3755.0	1.58	6415.0	3845.0	1.67
Toronto West	-10950.0	9739.0	-1.12	-29440.00	6412.0	-4.59
Detached House	10320.0	9607.0	1.07	27780.0	6690.0	4.15
Interest Rate	-39.03	390.0	-0.10	37.42	398.5	0.09
Constant	79890.0	22380.0	3.57	101600.0	21110.0	4.81

Table 2
Regression Results for Pascal-squared Seconds (Eldred):
MTC Data Set

	Including Original Price			Not Including Original Price		
	Regression Coefficient	Std. Error	t value	Regression Coefficient	Std. Error	t value
Variable						
Original Price	1.90	0.78	2.48	-	-	-
Eldred Measure	-0.000394	0.0003	-1.34	-0.00037	0.0003	-1.23
Lot Area	1.53	1.46	1.05	2.75	1.41	1.95
Toronto Centre	6571.0	3750.0	1.75	7048.0	3837.0	1.84
Toronto West	-9931.00	9806.0	-1.01	-28390.0	6424.0	-4.42
Detached House	10856.0	9669.0	1.12	28240.0	6724.0	4.20
Interest Rate	-35.30	388.0	0.09	109.0	397.0	0.28
Constant	48350.0	13100.0	3.69	71260.0	9397.0	7.58

Table 3
Dummy Variable Regression for Noise Levels
MTC Data Set

Variable	Including Original Price			Not Including Original Price		
	Regression Coefficient	Std. Error	t value	Regression Coefficient	Std. Error	t value
Original Price	1.68	0.79	2.12	-	-	-
Noise Levels:						
58-60.9	2856.0	4177.0	0.68	4783.0	4150.0	1.15
61-63.9	-4087.0	3872.0	-1.06	-3536.0	3933.0	-0.90
64-66.9	-3010.0	4122.0	-0.73	-2671.0	4193.0	-0.64
67-69.9	-6251.0	3761.0	-1.66	-5569.0	3814.0	-1.46
70-72.9	-1565.0	5914.0	-0.27	-100.0	5979.0	-0.02
Toronto Centre	5856.0	4290.0	1.36	5769.0	4367.0	1.32
Lot Area	1.40	1.50	0.93	2.45	1.44	1.70
Toronto West	-11627.0	10222.0	-1.14	-27550.0	7052.0	-3.91
Detached House	10877.0	9965.0	1.09	25720.0	7214.0	3.56
Interest Rate	-152.6	400.0	-0.38	-105.9	407.0	-0.26
Constant	57230.0	14152.0	4.04	77640.0	10550.0	7.36

Table 4
Variables used in analysis of Toronto Real Estate Board data, and pooled sample characteristics (n=394)

CATEGORIES, REPRESENTED BY BINARY VARIABLES

	percentage of sample in each category
Location in the city:	
West (near Hwy 427)	34.5%
Central (Leslie St)	26.1%
East (Victoria Park)	39.3%
Dwelling type:	
one-storey detached	44.4%
two-storey detached	14.0%
one-storey semi-detached	41.1%
two-storey semi-detached	0.5%
Driveway type	
private	97.0%
shared	3.0%
Size of garage	
single-car	25.9%
two-car	14.7%
carport	10.7%
no garage	48.7%
Basement condition	
finished	51.8%
partly finished	33.2%
unfinished	14.2%
Presence of central air conditioning	24.9%
Presence of a swimming pool	14.5%

VARIABLES MEASURED ON RATIO SCALE

	mean value in sample
Number of rooms	6.89
Number of bedrooms	3.38
Number of bathrooms	1.64
Number of fireplaces	0.22
Number of appliances included	1.43
Number of additional apartments in the house	0.04
Lot size (sq. ft.)	5307.
Recent sale price (constant 1981 $)	102476.

VARIABLES OBTAINED ELSEWHERE	mean value in sample
Calculated sound level at house (dB, 24-h L_{eq})	60.3
Presence of a barrier (absent at most Etobicoke sales)	69.3%
Price index for housing sales (1981 = 100)	0.9517
Interest rate on 5-yr mortgages at time of sale	14.1%

Table 5
Regression coefficients for functions containing 24-hour L_{eq}, using all 21 variables for the Victoria Park site (n=155)

Independent variables	Regression coefficient	t-statistic
24-hour L_{eq}	-312.11	-1.68
constant term	93828.00	7.46
1-storey semi-detached	-11834.00	-4.92
2-storey detached	25461.00	6.82
1-car garage	6844.00	3.85
swimming pool	6096.00	3.40
number of rooms	1357.00	1.73
number of bedrooms	1393.00	1.03
mortgage interest rate	257.00	0.98
partly finished basemt	-2792.00	-1.48
number of bathrooms	1984.00	1.17
number of fireplaces	1491.00	0.71
finished basement	-1383.00	-0.78
2-car garage	3343.00	0.80
carport	1253.00	0.71
no. of additional apts	-1920.00	-0.53
shared driveway	1020.00	0.41
2-storey semi-detached	1161.00	0.20
no. of appliances incl	-68.00	-0.18
lot size	-0.0664	-0.11
central air condition	-58.00	-0.04

The adjusted R-squared for the equation is 0.6416

Notes: The implied base case for the regression is a 1-storey detached house with an unfinished basement and a private driveway.

The value of t required for significance at the 5% level for a one-tailed test is 1.645, and for the 1% level is 2.326

Table 6
Regression coefficients on noise, by areas in Toronto
(t-values in parentheses)*

Noise measure		Victoria Park site	Etobicoke site	Leslie Street site	Pooled sample
24 hour L_{eq}		-312.11	-356.00	-2970.67	-775.26
		(-1.68)	(-2.36)	(-2.30)	(-3.28)
Pascal-squared seconds		-23.06	-12.33	-99.45	-27.34
		(-1.96)	(2.21)	(-2.05)	(-2.67)
Intervals:	58-60	1816.00	-6809.00	base	1648.00
		(1.072)	(-3.05)	case	(0.59)
	61-63	451.00	1583.00	-18208.00	-6634.00
		(0.16)	(0.68)	(-1.77)	(-1.92)
	64-66	54.00	-5889.00	-7208.00	-4453.00
		(0.03)	(-1.77)	(-0.37)	(-1.23)
	67-69	-3384.00	-3660.00	-20107.00	-9222.00
		(-1.31)	(-1.49)	(-1.69)	(-2.54)
	70-72	zero	-9060.00	-34386.00	-9857.00
		observatns	(-2.19)	(-1.52)	(-1.30)
Sample Size		155	136	103	394

* The critical values of t are 1.645 for the .05 level and 2.326 for the .01 level.

Table 8

House Price and Noise Level Distribution for Leslie St. Site
(FREQUENCIES)

	All obs. at site	50K-100K	100K-150K	150K and Up
52-54.9 dB	0	0	0	0
55-57.9 dB	0	0	0	0
58-60.9 dB	68	11	17	40
61-63.9 dB	20	13	5	2
64-66.9 dB	2	1	1	0
67-69.9 dB	11	6	4	1
70-72.9 dB	2	1	1	0
Sample size	103	32	28	43

Figure 1

House price effect relative to 55 dB

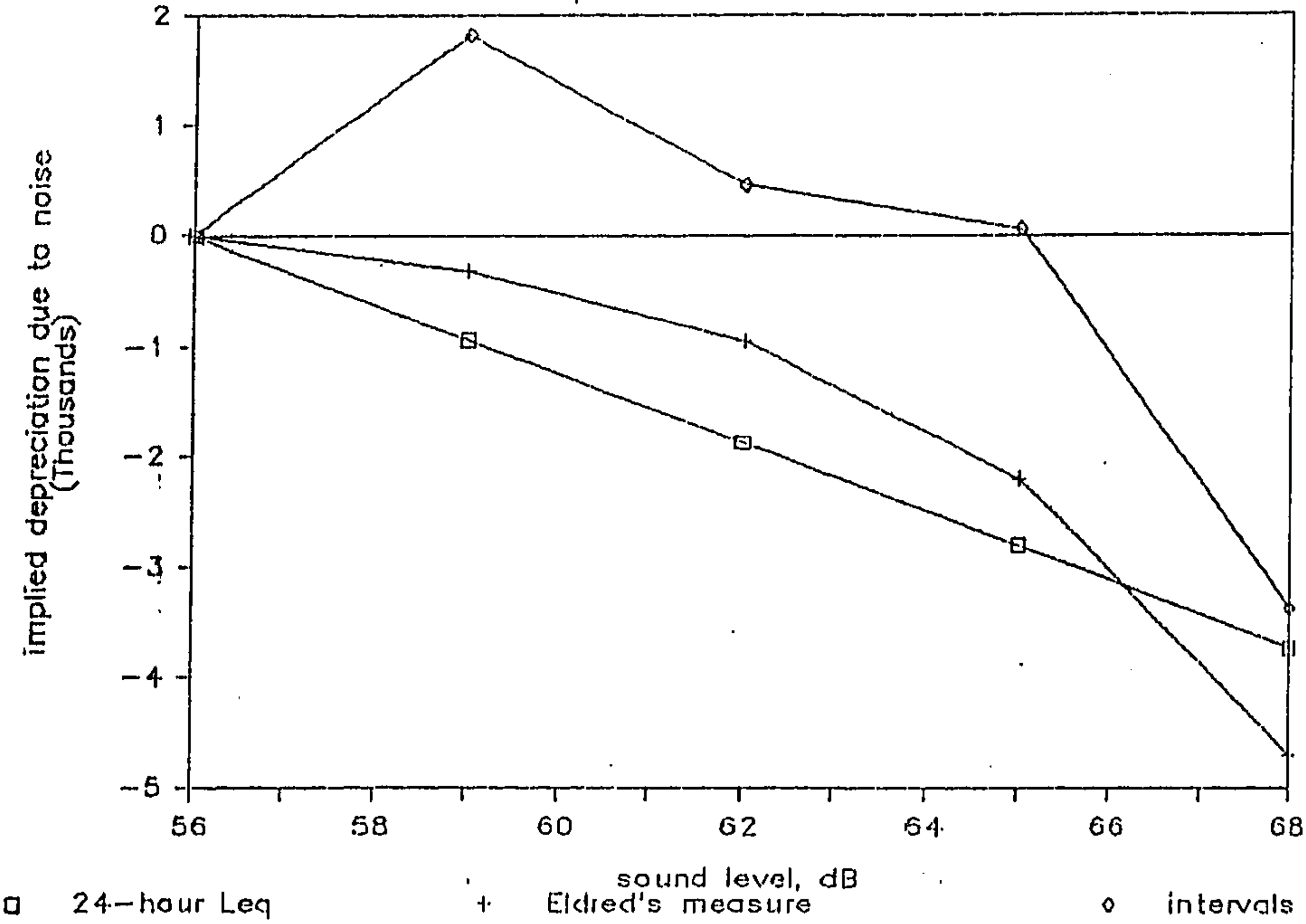
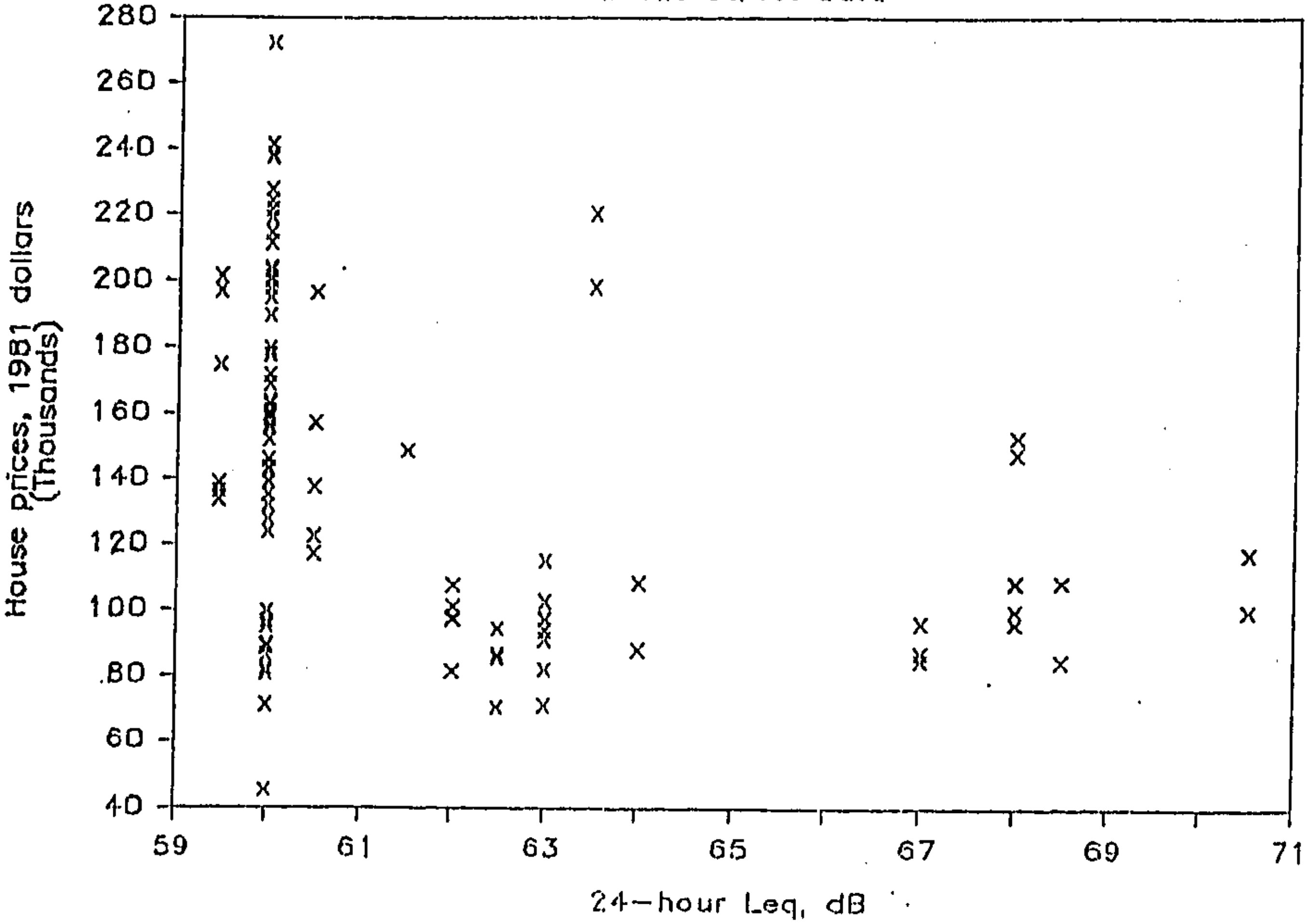


Figure 2

Leslie Street data



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